

RSMON Related Issues

Contents :

RSMON Data Analysis

LED light Intensity Stability

Run-by-Run Gain Fluctuation

Correction for Rate and TIS Effect

Correction quality (Self Correction)

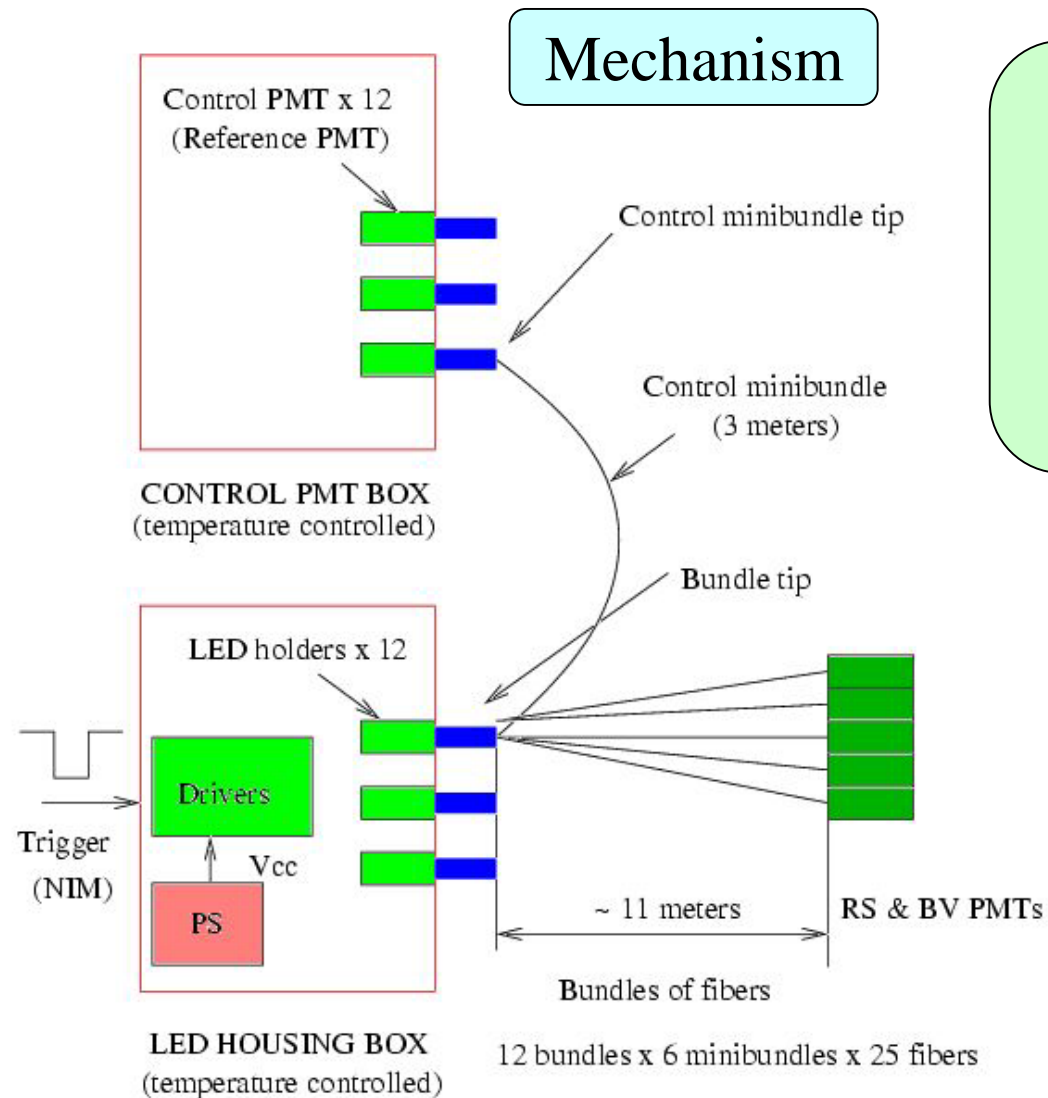
Energy Correction Based on RSMON

Collaboration Meeting @ BNL

Feb 10 2003

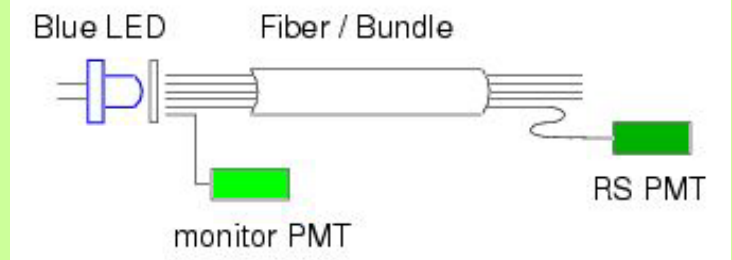
RSMON(Range Stack Gain Monitor) System

Mechanism



Blue LEDs are illuminated on time of the external trigger.

LED light is distributed to all RS PMTs via optical fibers, and their ADC values are recorded.




The light intensity can be normalized by reference PMTs.

RSMON Data Set

Brief Description for Data Sample


RUN Range : 47592 ~ 50218 (about 1600 runs)

RSMON Events are taken in standard-mixed run.
(not in special runs.)

$$912 [\text{RS PMTs}] \times 3 [\text{events/spill}] \times 670 [\text{spills/hour}]$$


~2000 events / hour

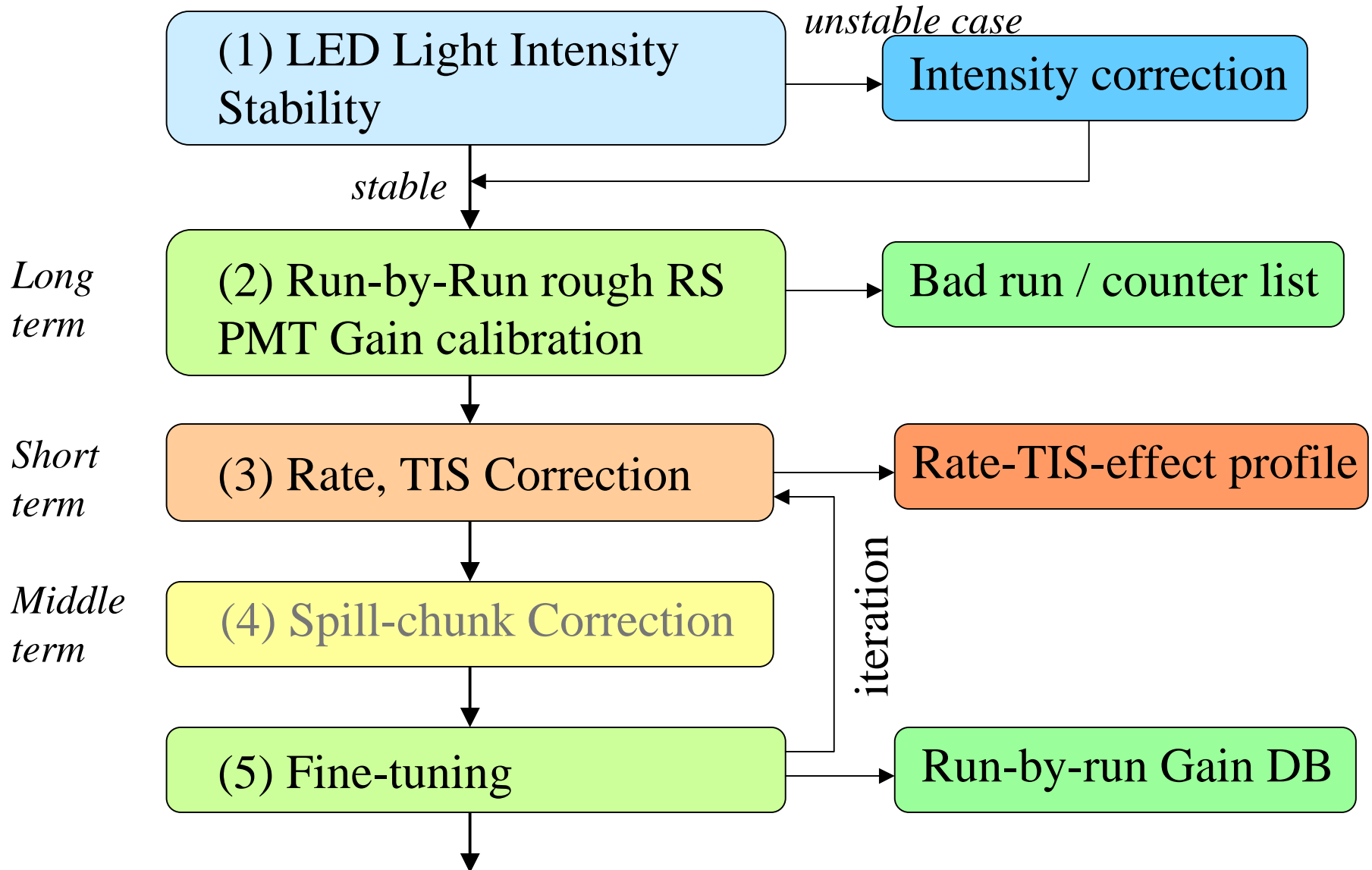
RSREF Events are taken in standard-mixed run.

$$12 [\text{REF PMTs}] \times \frac{1}{12} [\text{events/spill}] \times 670 [\text{spills/hour}]$$


~56 events / hour

Explanation of “RSREF” can be seen in next section. (RSMON Reference System)

RSMON Data Analysis [Road Map]

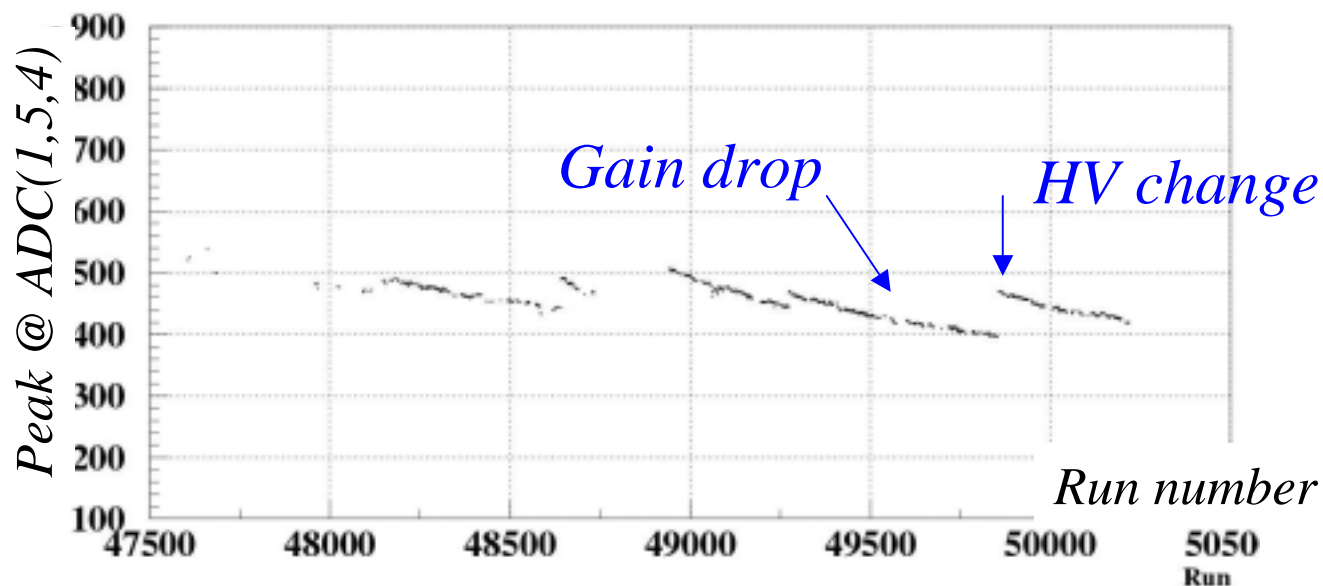


[Road Map] Appendix - 1

*Long
term*

(2) Run-by-Run rough RS
PMT Gain calibration

As time goes, PMT gain gets change. We want to track the gain run-by-run.



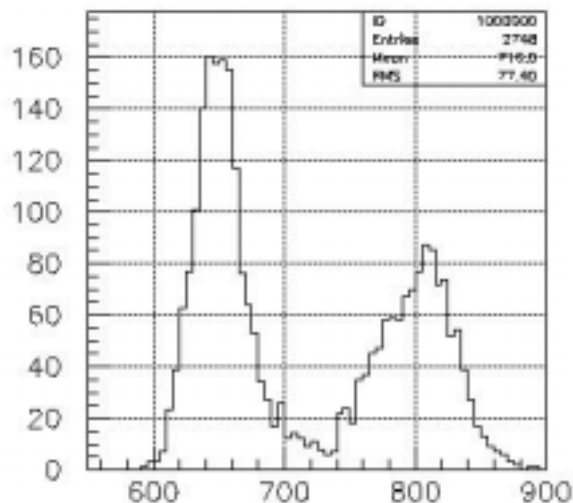
The process where we estimate run-by-run gain shift roughly is called as “*pre-calibration*” in this analysis.

[Road Map] Appendix - 2

*Short
term*

(3) Rate, TIS Correction

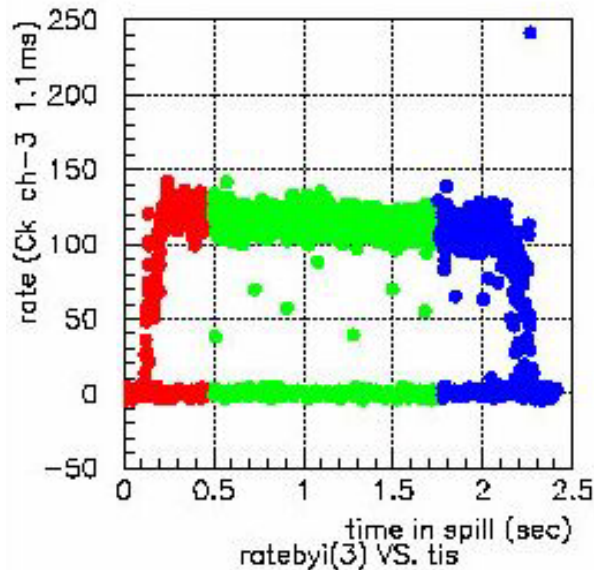
*It is not so hard to imagine that run-by-run gain fluctuation is there more or less. But we can see other **short term** effect. (Short term means “INSIDE a spill”)*



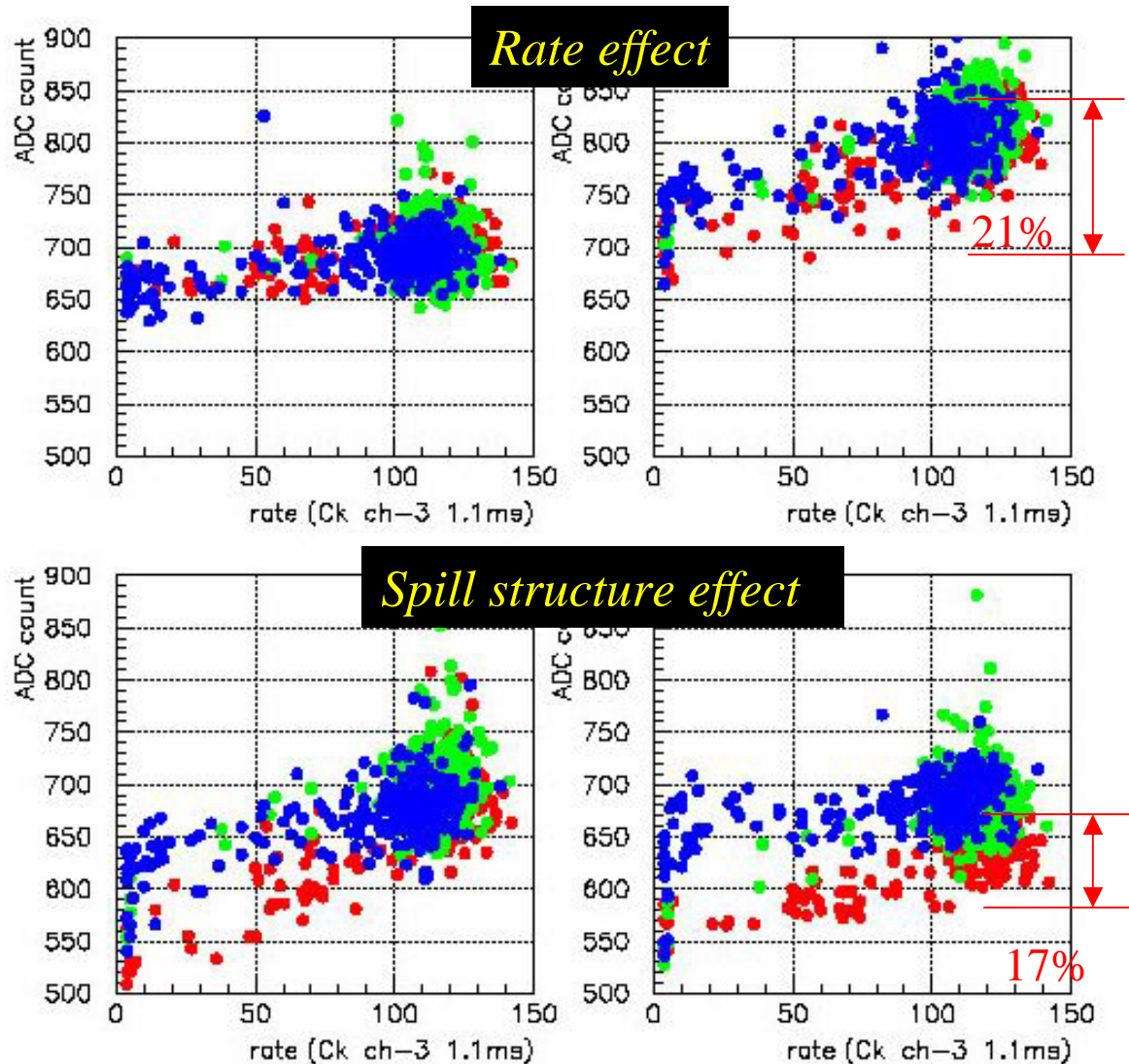
See next transparency ...

*Funny ADC distribution @ a certain PMT
(RSMON triggered events) in ONE run.*

Rate dependency / Spill structure effect



Spill Structure



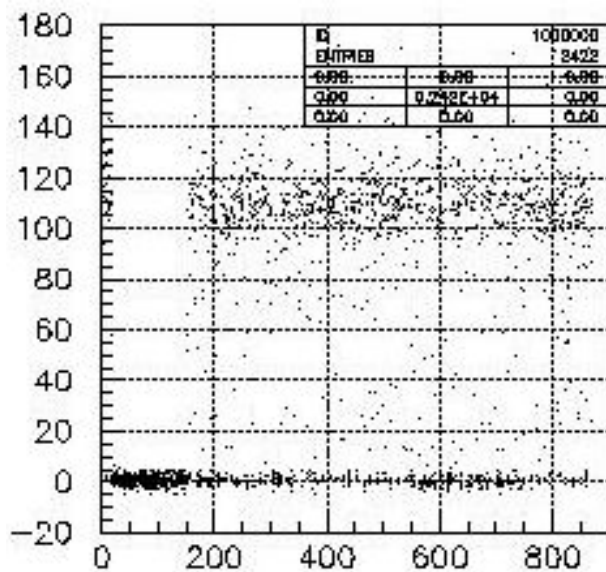
4 different PMTs in Layer 2

[Road Map] Appendix - 3

Middle
term

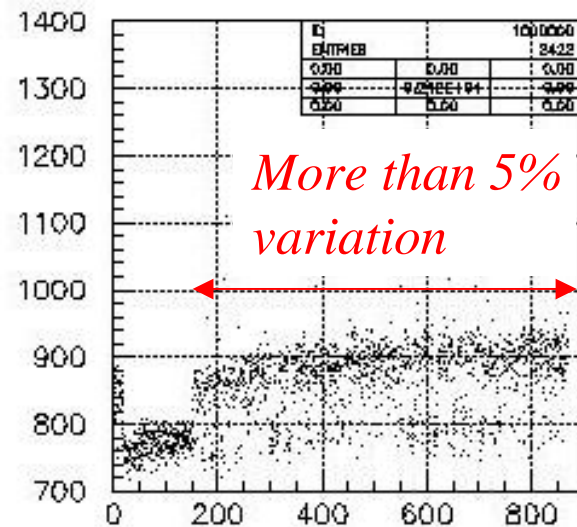
(4) Spill-chunk Correction

RUN 50007

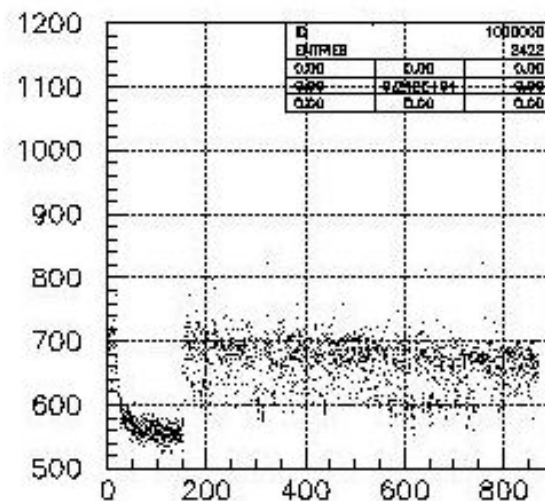


rate(3) VS. spill

Ck rate is kept relatively stable after off-spills.



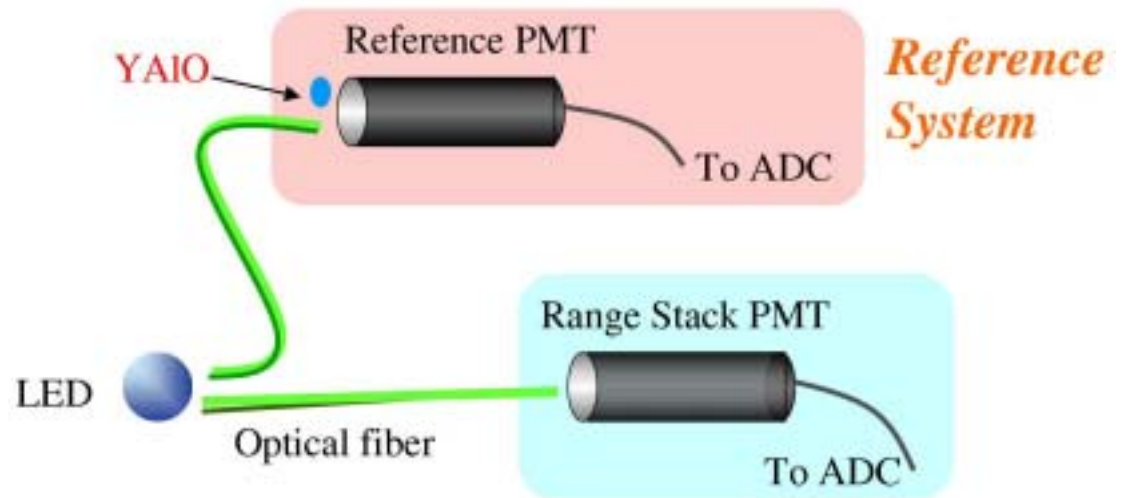
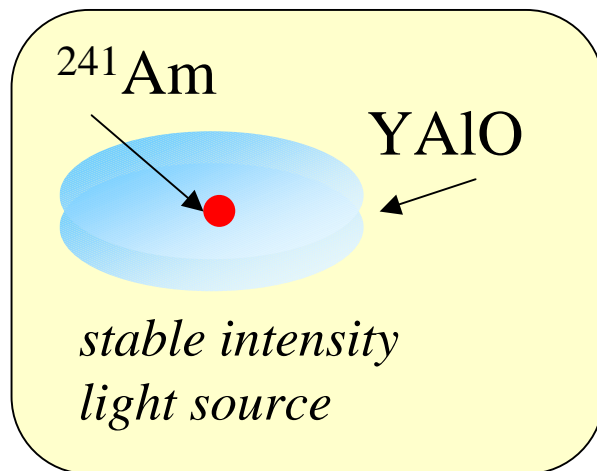
adc(1,2,12) VS. spill



adc(1,3,2) VS. spill

RSMON Reference System

- (1-1) Reference YAlO Event (RSREF Trigger)
- (1-2) Reference LED Event (RSMON Trigger)



- (1) Know the fluctuation of *Reference System* itself.
- (2) And reveal the variation of *LED light intensity* by compensating it.

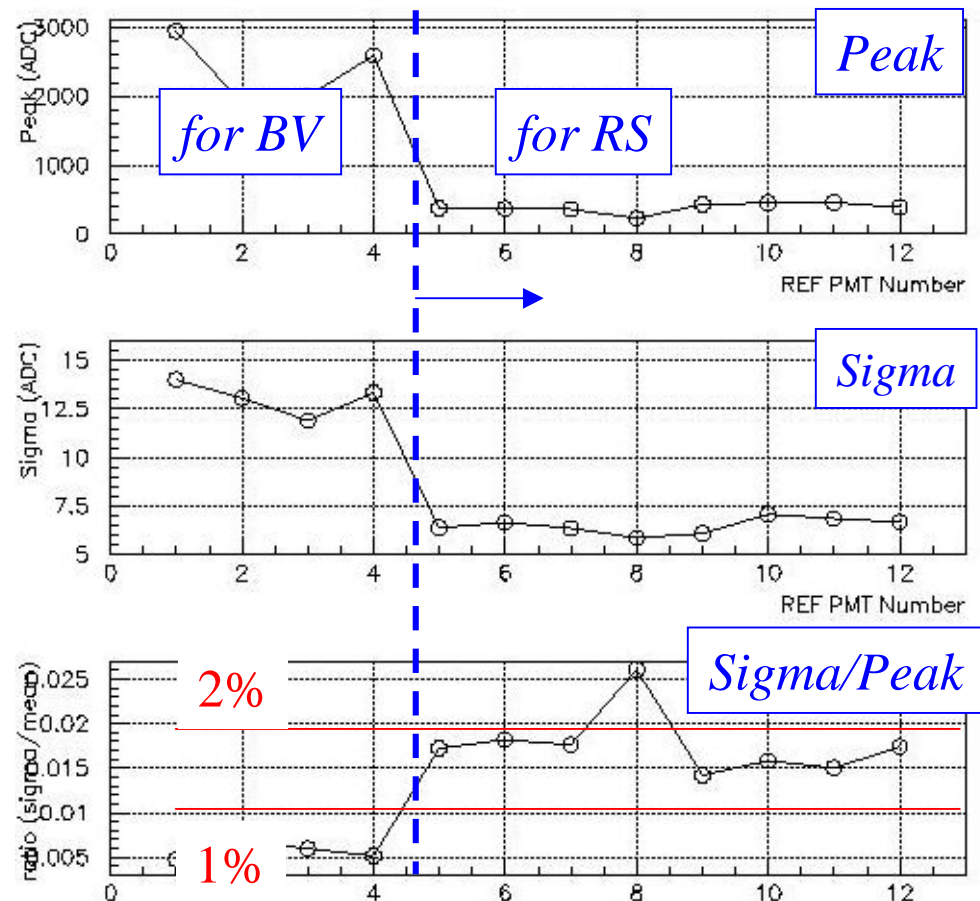
Reference LED Events

LED Events make **very sharp** distribution. "sigma/peak" is very small and same as photo statistics prediction.

System can track the LED intensity fluctuation with less than 0.5 % accuracy, if run has more than 25 events.

Very *accurate* LED intensity tracking tool.

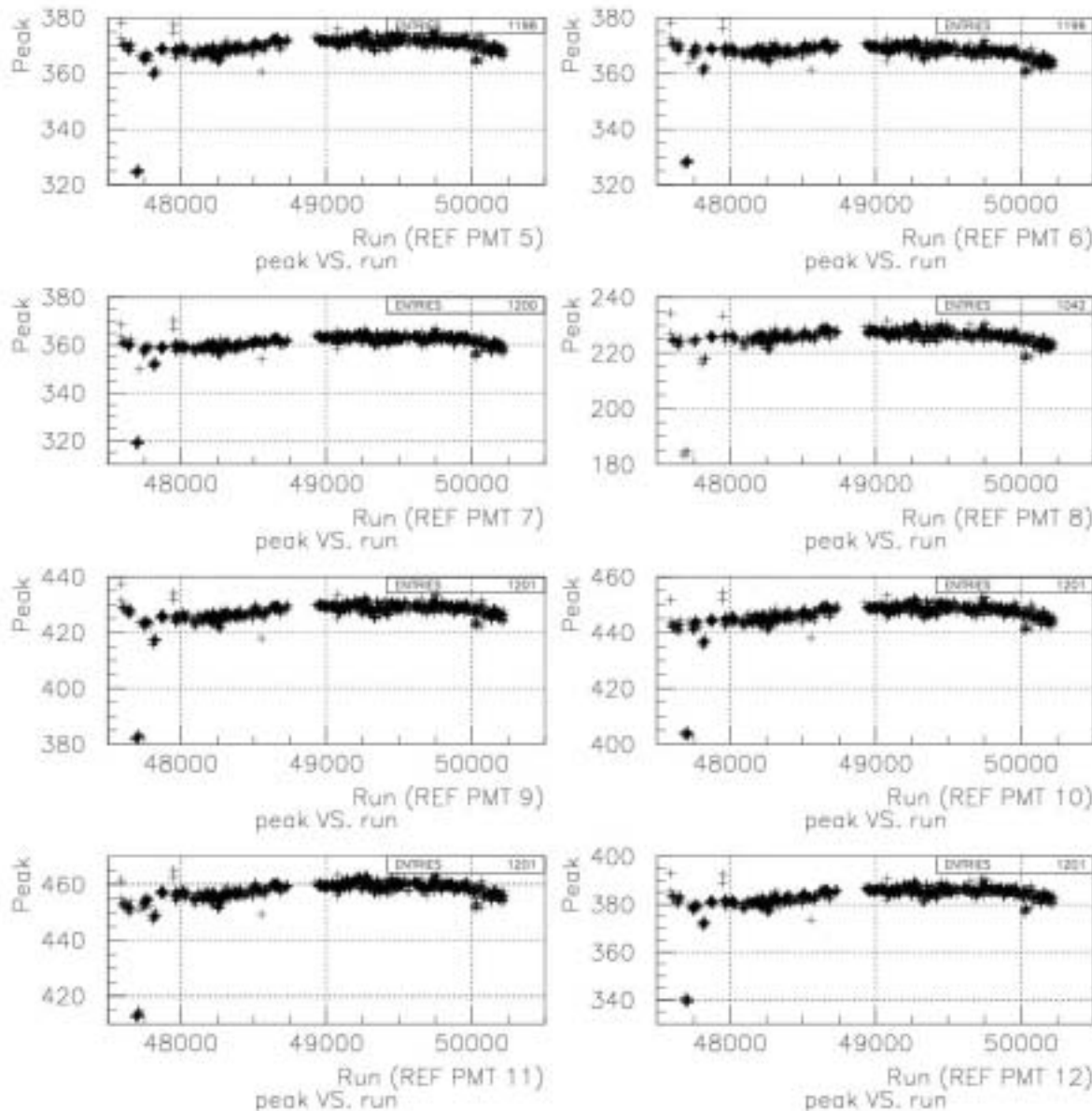
[LED Event Performance]



~ 2 hours

Index of REF PMT in on X-axis.

Run-by-Run Stability of RS LED Events



Fluctuation Width :
within 3%

Tendency :
 Correlated each other.

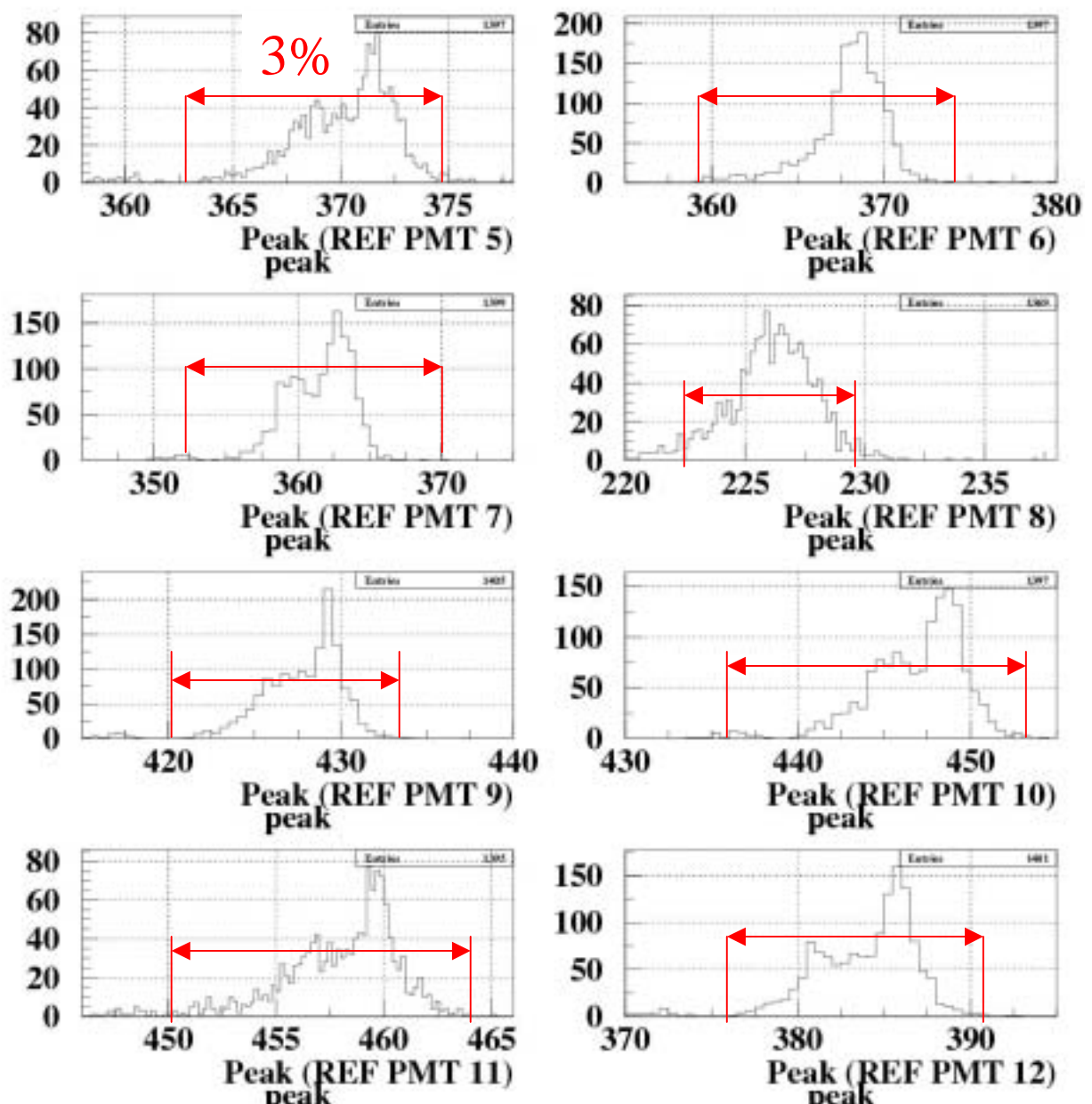
Error : Each point
 has 0.4% error.

Fluctuation of reference
 system including REF
 PMT and electronics
 gain variation is
< 3%.

Run-by-Run Stability of RS LED Events

Appendix

[REF LED Events]
Peak variation
through the entire
run.



Reference YAlO Events

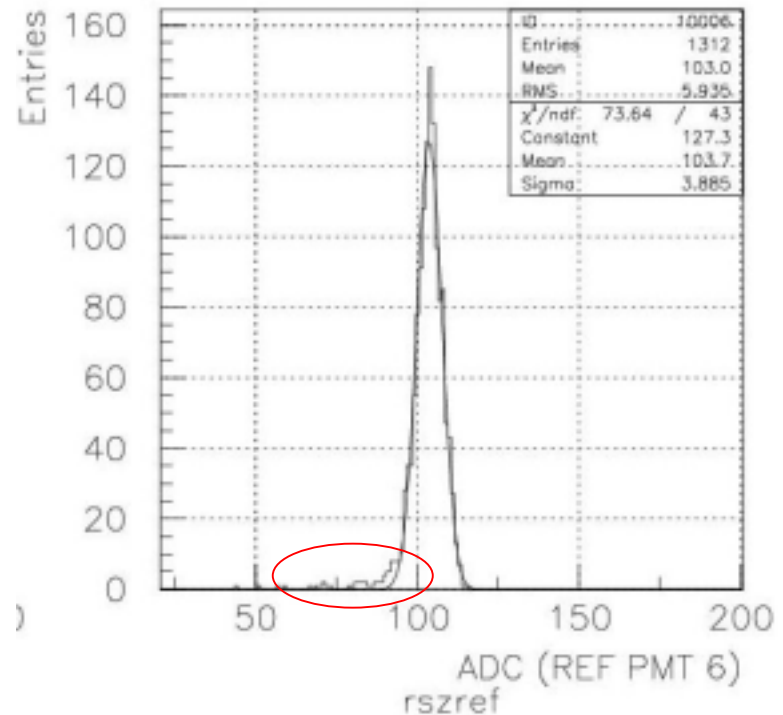
ADC peak width is also narrow as LED events.

Sigma is around 3 ~ 5 [ADC count]
Peak is ~ 100 [ADC count]

If we have 100 events
(corresponds to ~ 1.8 hour DAQ) in a run.

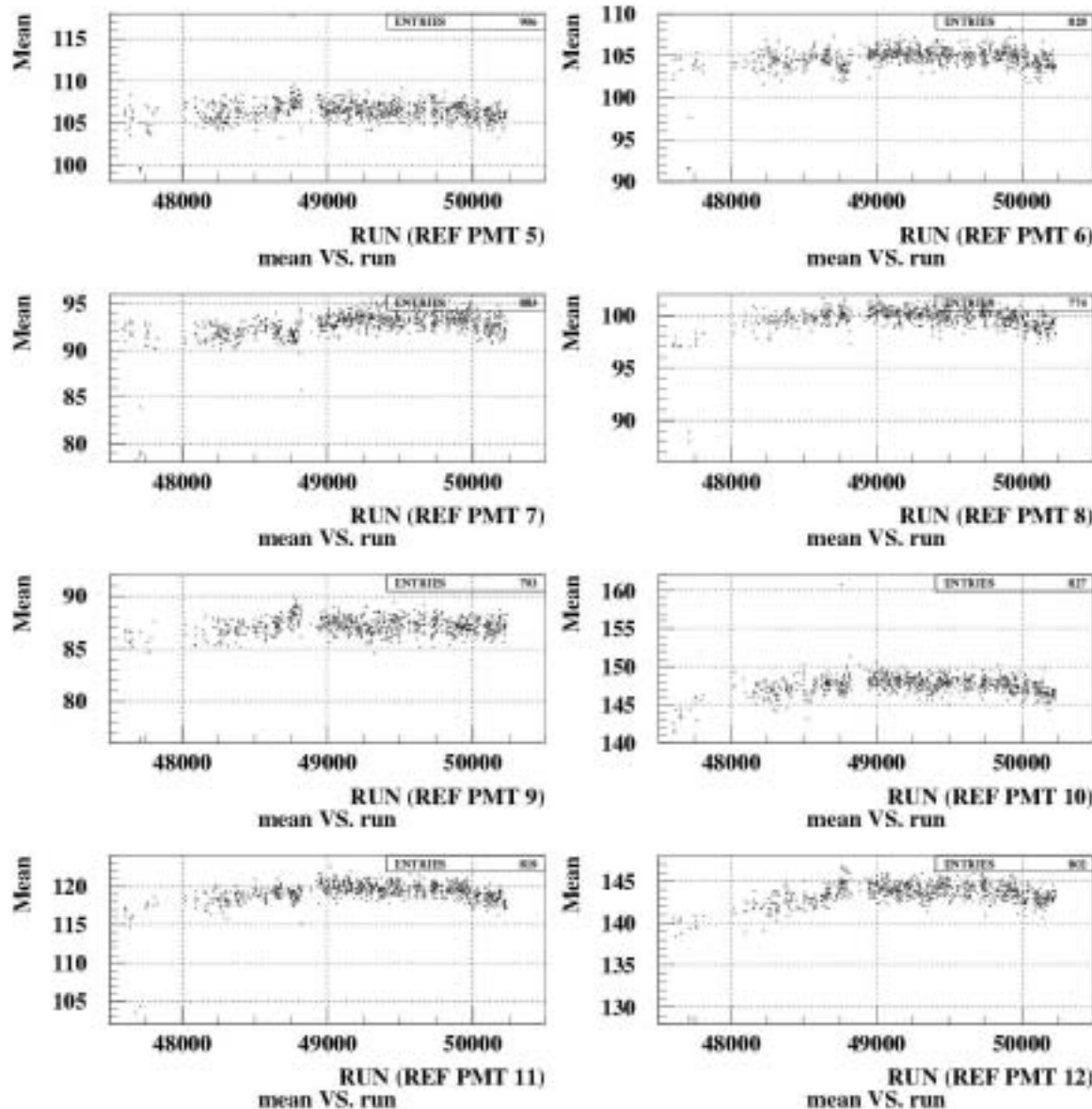
Peak uncertainty is
 $5 / \sqrt{100} / 100 = 0.5 \%$

YAlO ADC distribution



Histogram has lower tail, it means gaussian fitting might be needed. In that case, more statistics is required.

Run-by-Run Stability of RS YAlO Events



Fluctuation Width :
about 5 %

Tendency :
Same tendency as
LED events.

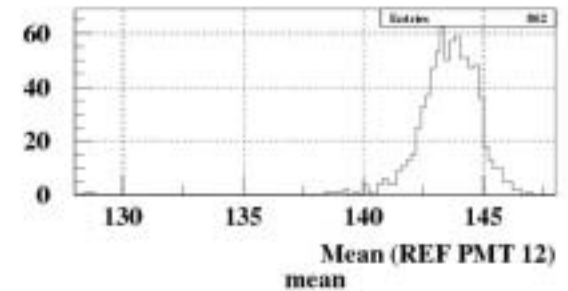
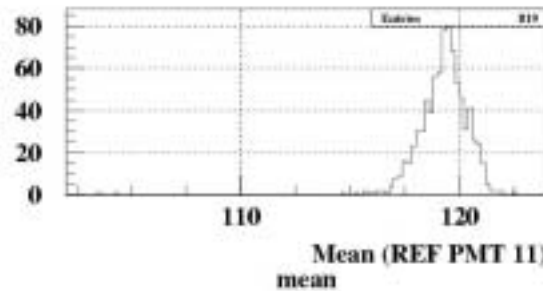
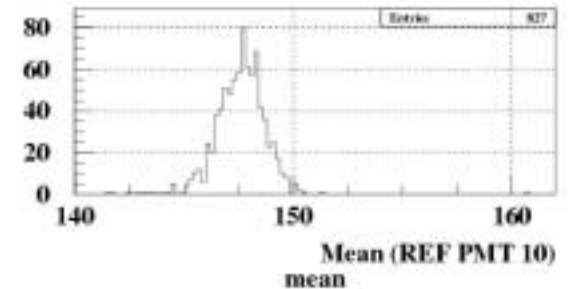
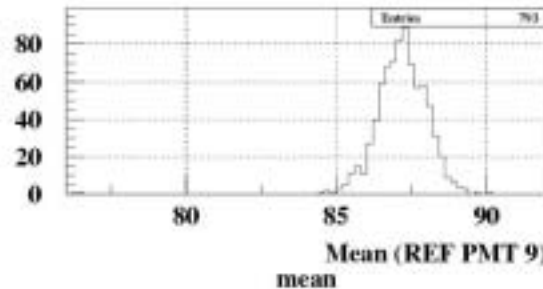
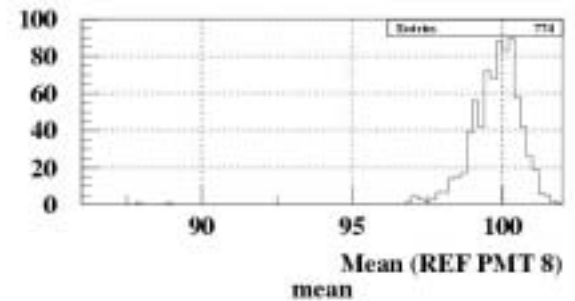
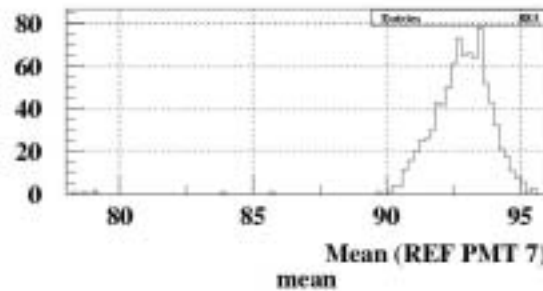
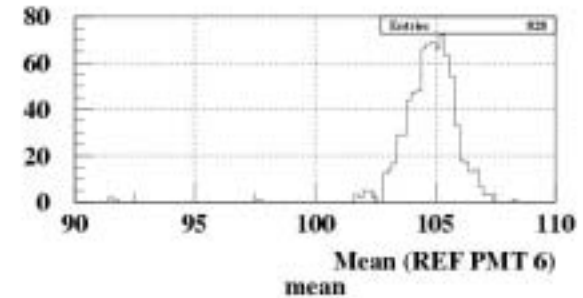
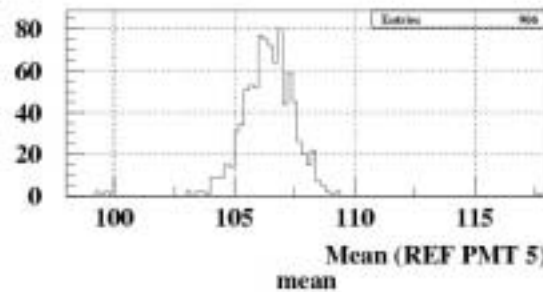
Error :
Each point has 1%
error.

Because of lower statistics,
it cannot have enough
accuracy in single run.

Run-by-Run Stability of RS YAlO Events

Appendix

[REF YAlO Events]
Mean variation
through the entire
run.

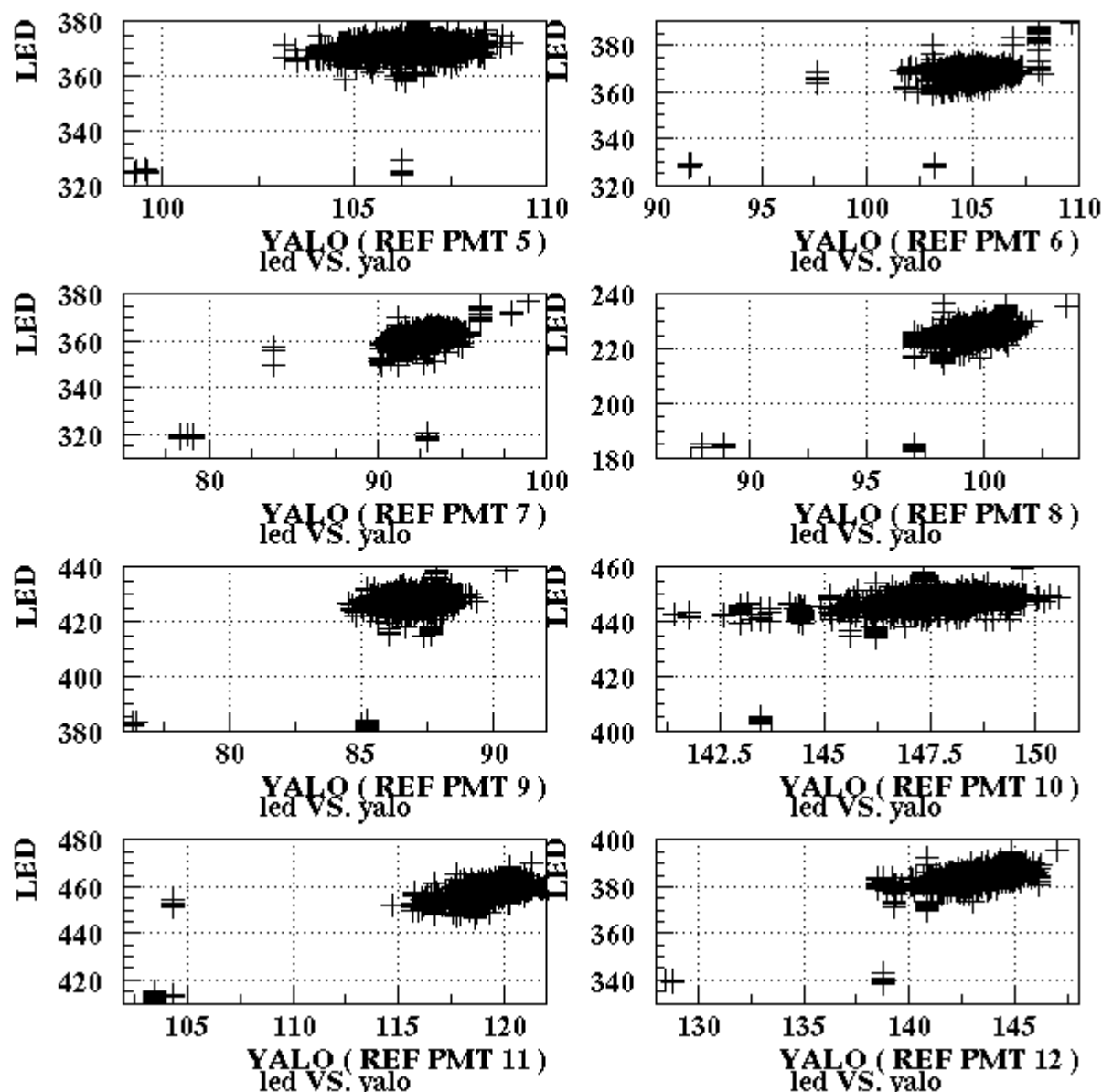


LED Events VS YAlO Events

Appendix

Correlation between
LED and YAlO
Events

LED vs YAlO Scatter plot

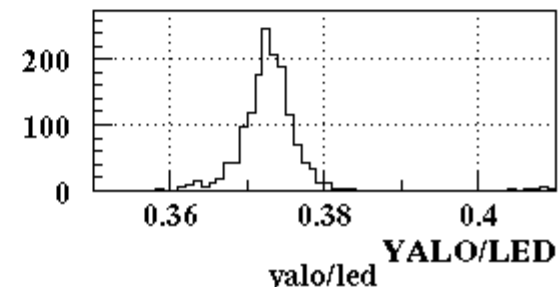
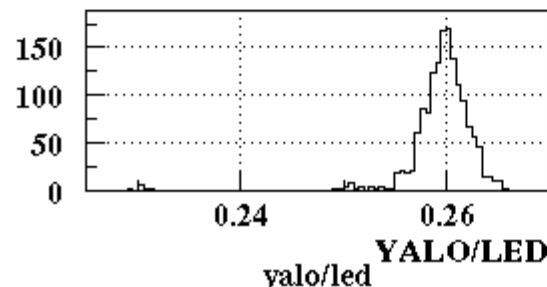
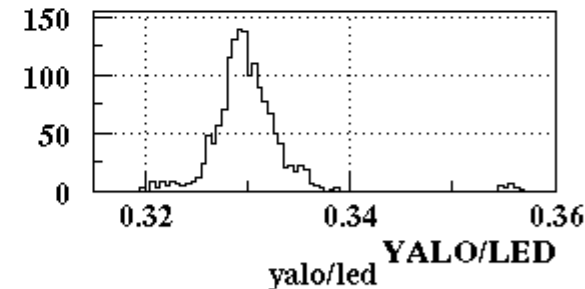
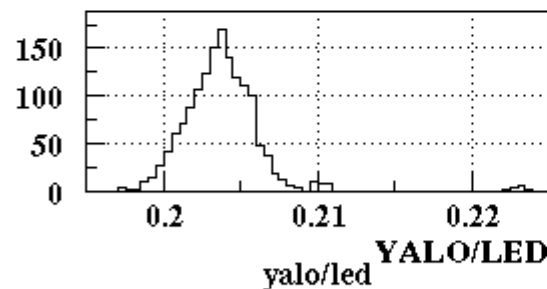
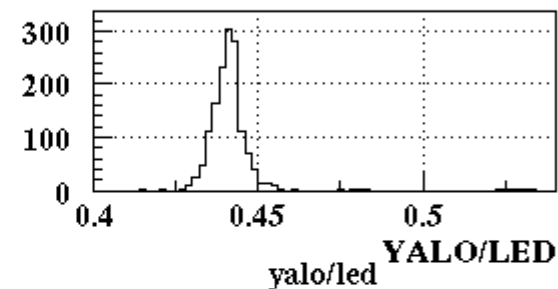
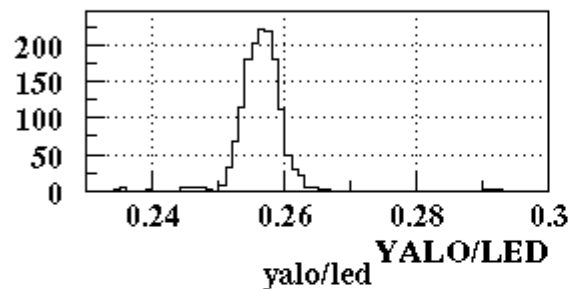
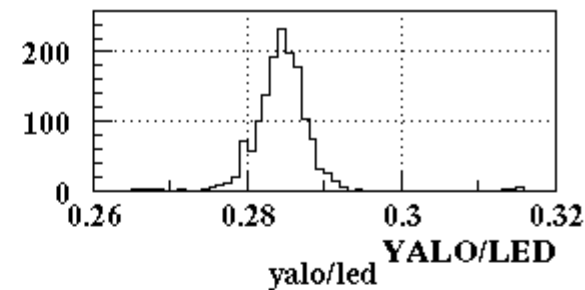
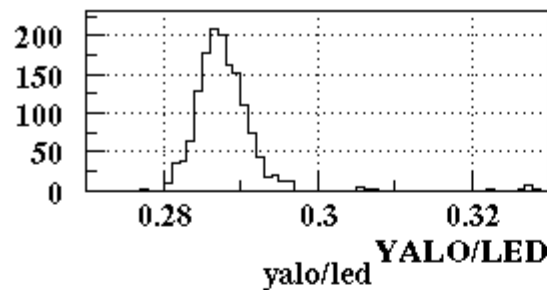


LED Events VS YAlO Events

Appendix

Correlation between
LED and YAlO
Events

YAlO/LED Ratio



LED Light Intensity

Summary

Fluctuation of Reference LED Events which **includes fluctuation from reference tubes and electronics** is less than **3%** though the entire run.

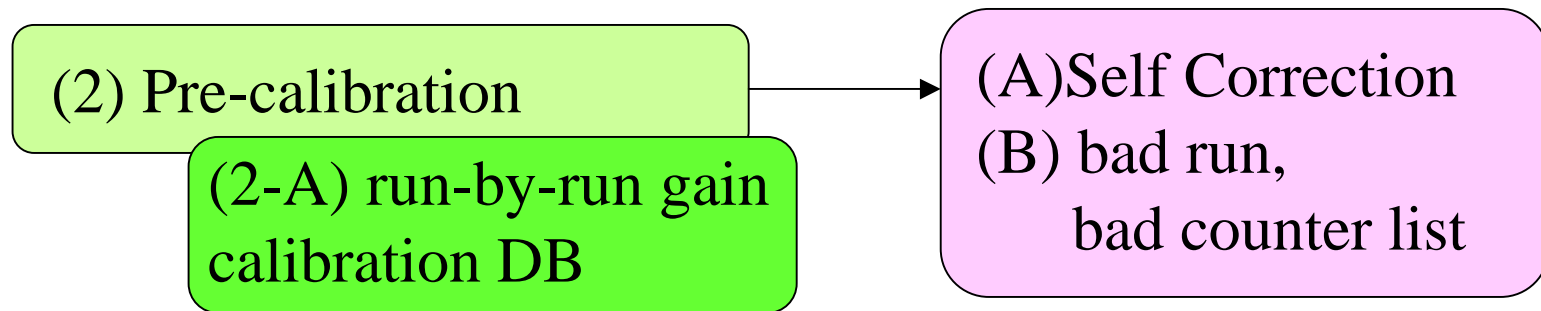
Reference YALO Events shows same behavior as Reference LED Events. And its fluctuation is **5%**

Variation of $\text{REF(LED)} / \text{REF(YALO)}$ is dominated by YALO's fluctuation.

PRE-CALIBRATION

What is “pre-calibration” ? And what is done in “pre-calibration”

*“pre-calibration” is a process where run-by-run gain variation table are made only using the event which is in **rate-TIS-effect independent region**.*

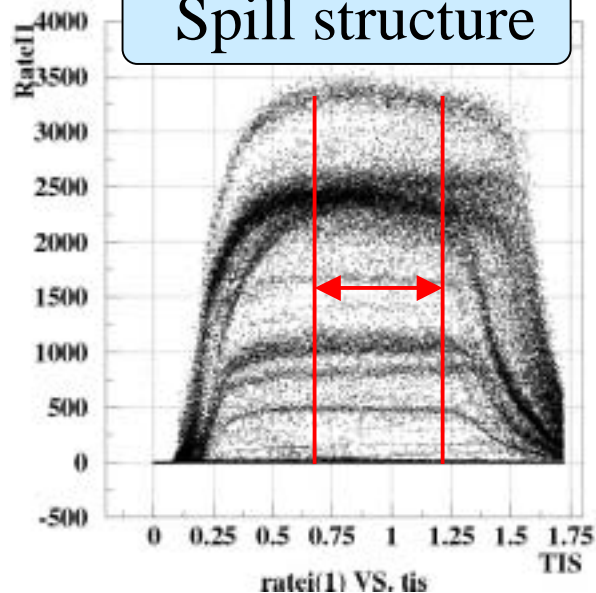


After pre-calibration, one can

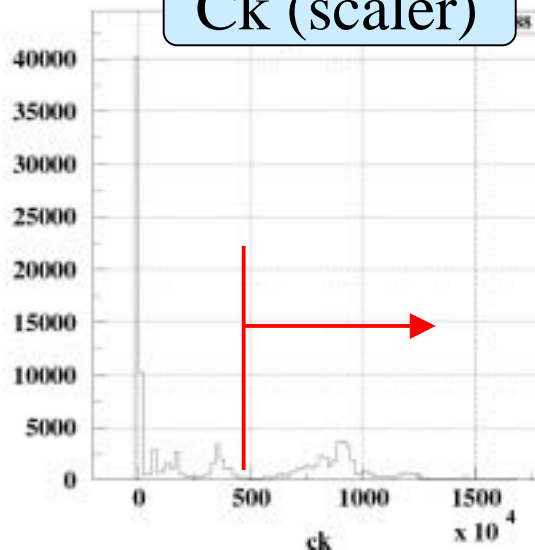
- (1) do rough run-by-run PMT gain correction.
- (2) get more strict profile of rate-TIS-effect by reducing the factor which blurs the effect.
- (3) estimate the goal of rate-TIS-effect correction.

Pre-calibration [Method]

Spill structure



Ck (scaler)



RUN<47830

SPILL 1.6/4.5 sec

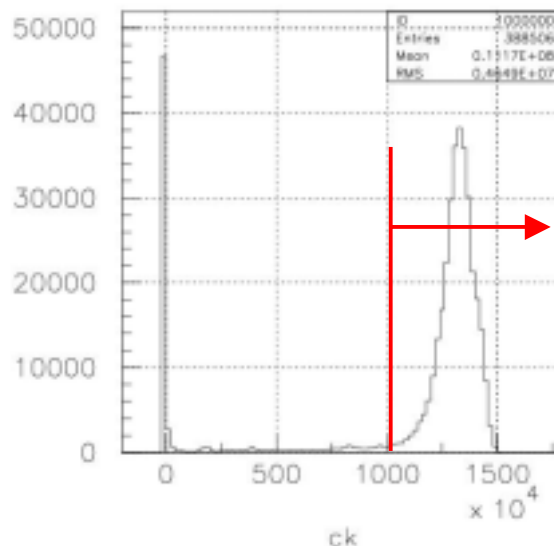
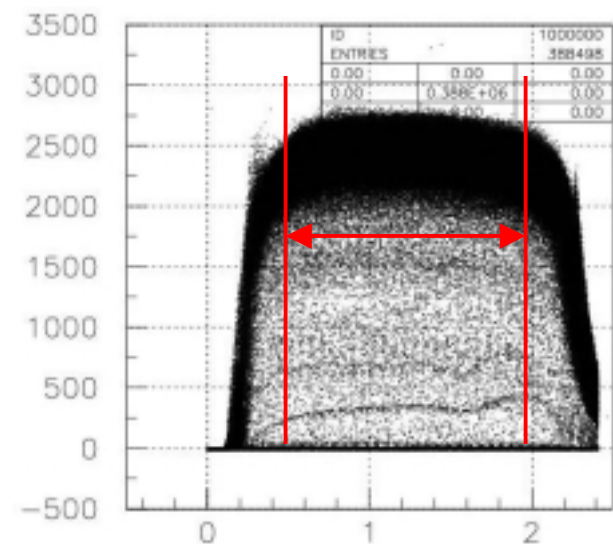
$0.7 < \text{TIS} < 1.2$

RUN>=47830

SPILL 2.2/5.4 sec

$0.7 < \text{TIS} < 2.0$

- (1) Make ADC histogram, only using the gain stable region for each PMT.
- (2) Peak finding by gaussian fit and record its peak, sigma and chisq.
- (3) Repeat (1) and (2) for the entire run



RS PMT Gain Tracking Resolution

Gain uncertainty is

< 1% @ layer-1

< 0.4% @ other layers

only with 500 events (~15 minutes DAQ)

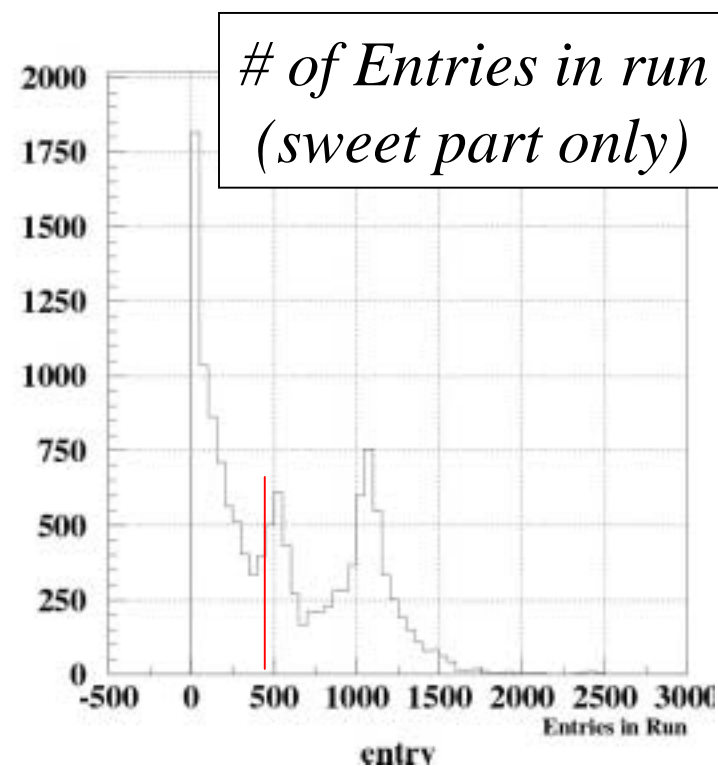
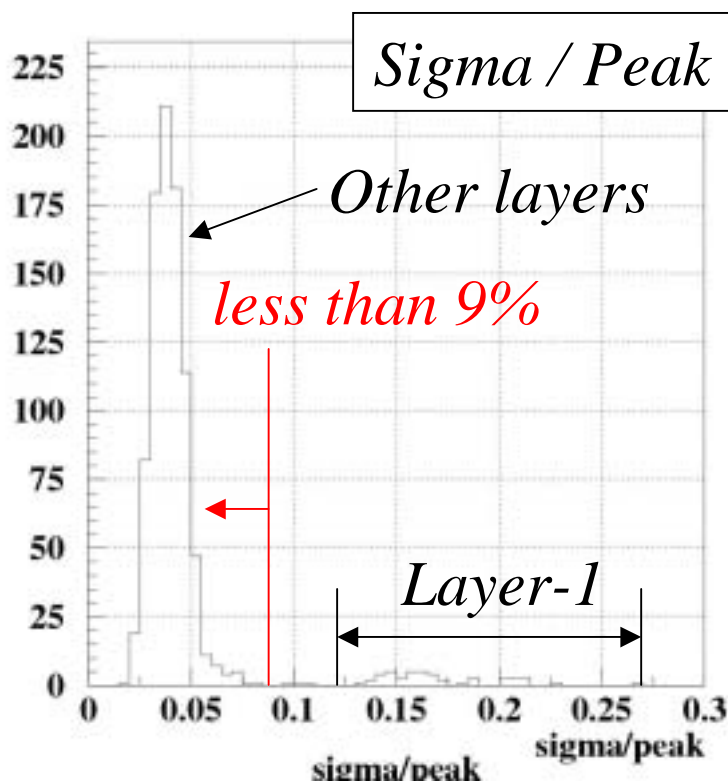
Very *Powerful* Gain Tracking Tool

Uncertainty

$$U \equiv \frac{\sigma}{\mu} \times \frac{1}{\sqrt{N}}$$

$$U = 0.09 \times \frac{1}{\sqrt{500}}$$

~0.4%



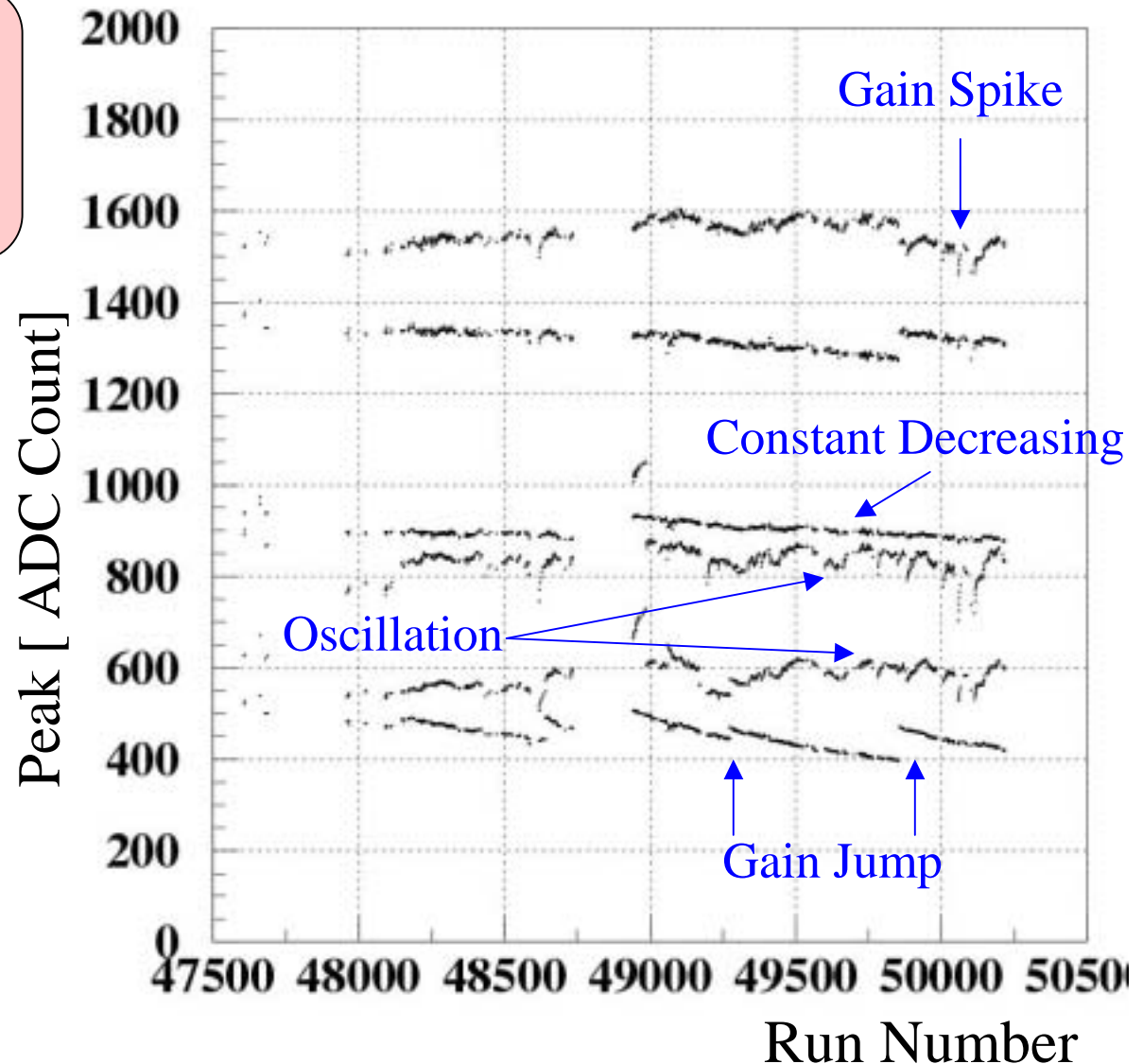
RS PMT Gain Tracking

THIS IS “RSMON”
GAIN TRACKING
ABILITY.

Various fluctuation
patterns

**IMPORTANT
NOTICE:**
These RS PMTs
are connected to
the **same** LED.

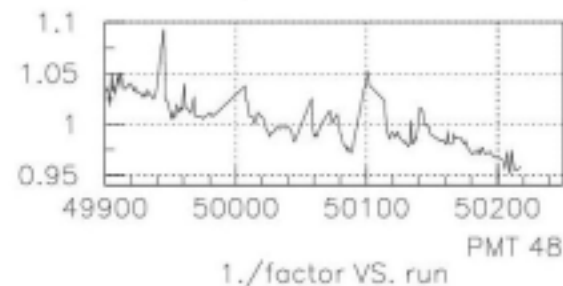
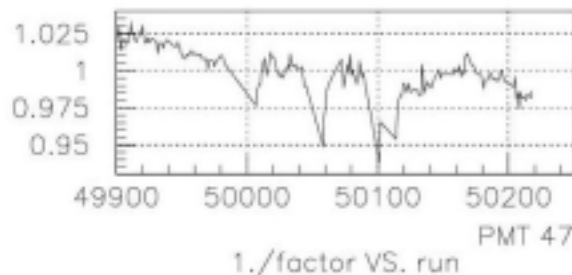
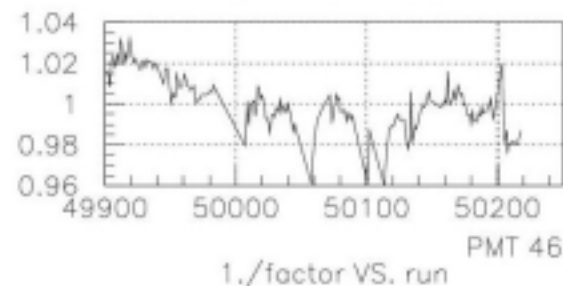
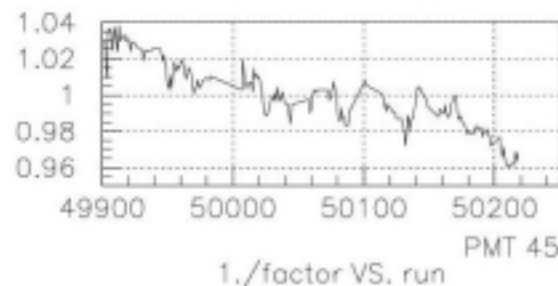
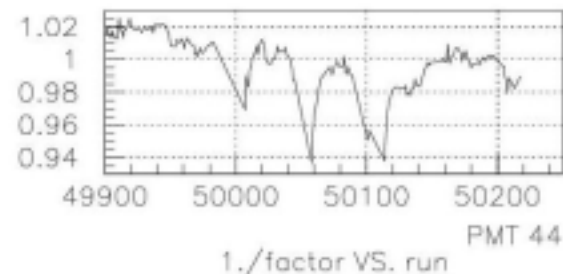
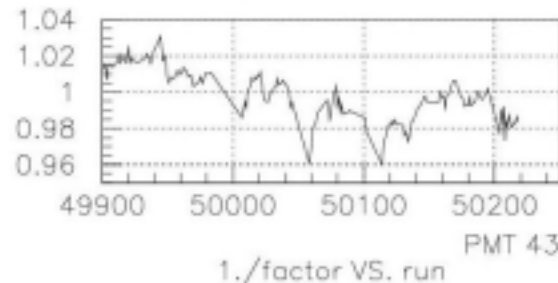
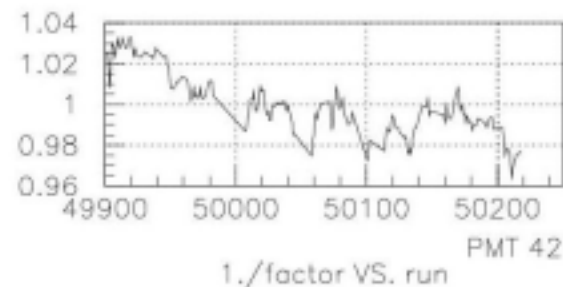
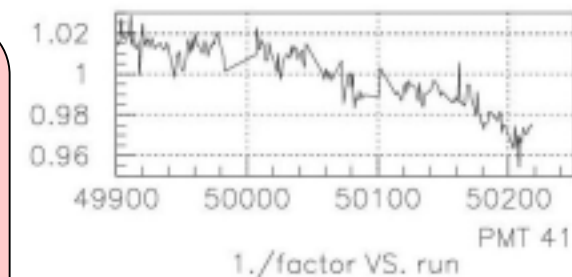
Error @ Each point
is $< 1\%$



Correction Factors in Database

Pre-calibration data is stored as rough run-by-run correction factors in database.

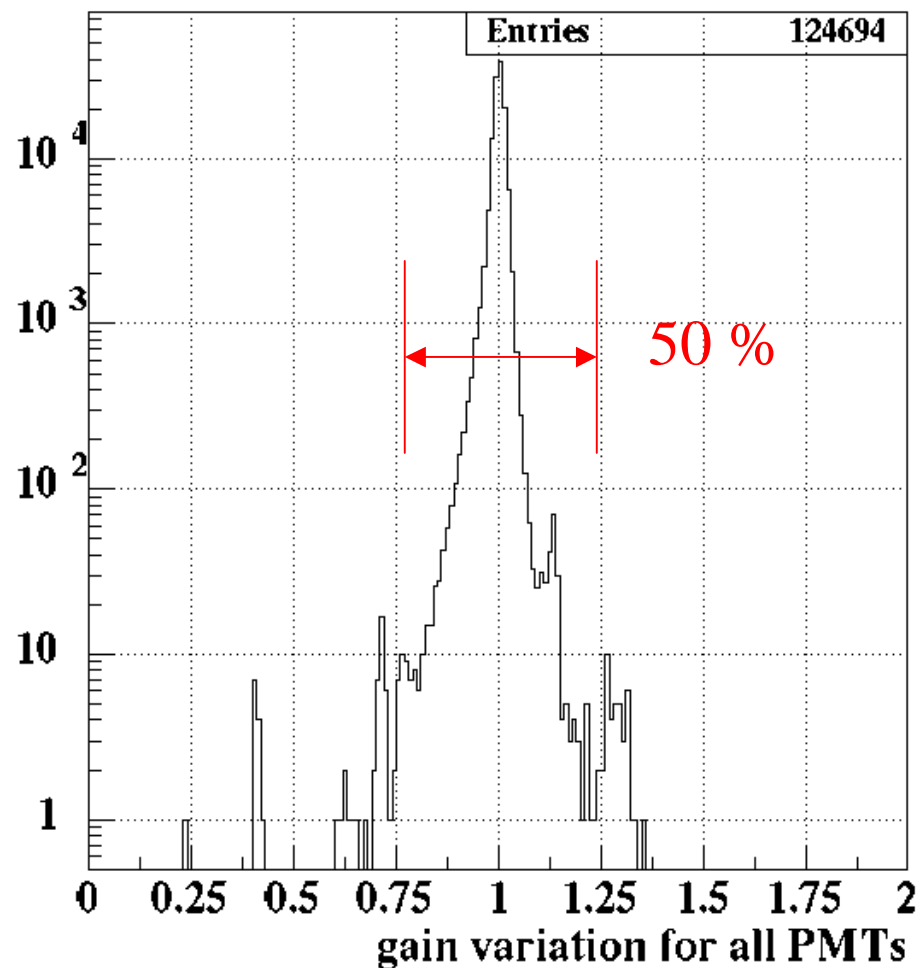
*Ex. Correction factors
for RS PMT
(RUN>49900)*



Gain variation from Database

After run 49900, PMT gain fluctuation width is $\sim 50\%$ *

* *Bad counter (ADC overflow) is excluded.*

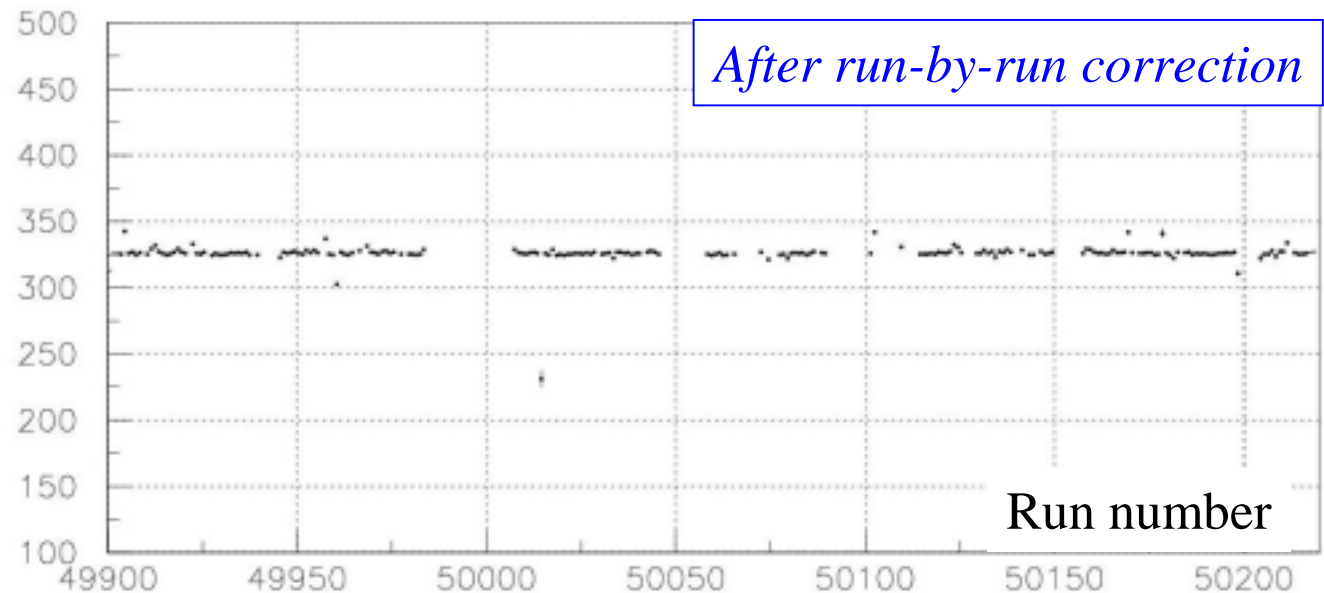
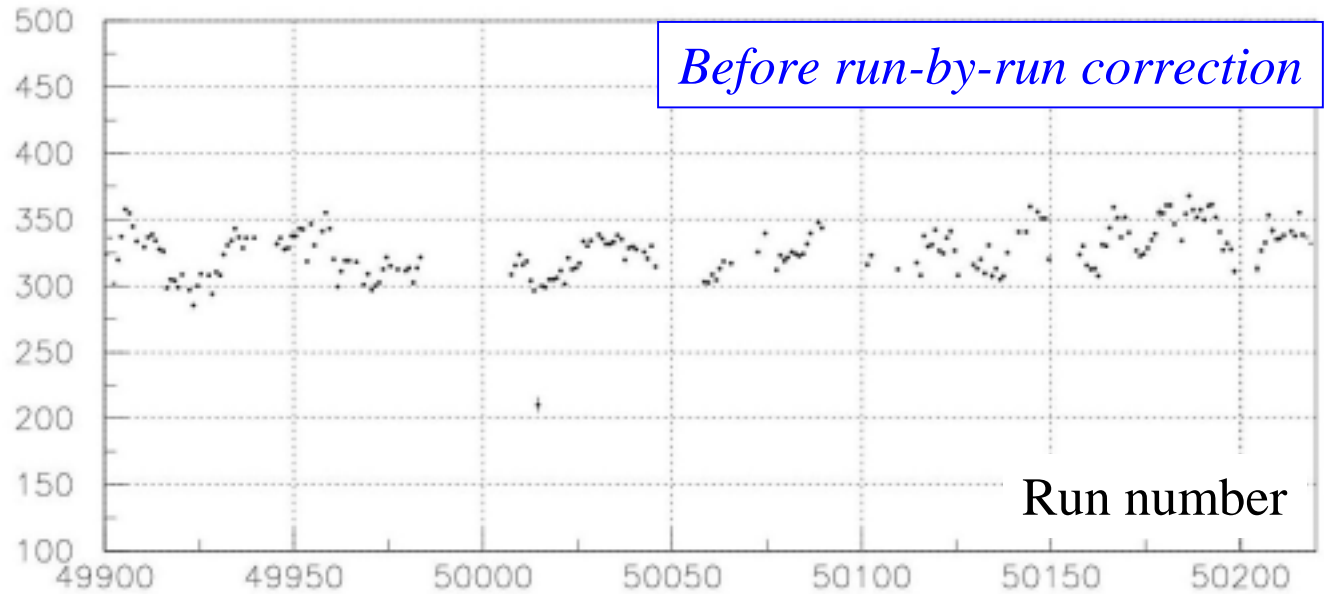


Self Correction

*Is gain variation
really suppressed
by the correction
based on pre-
calibration ?*

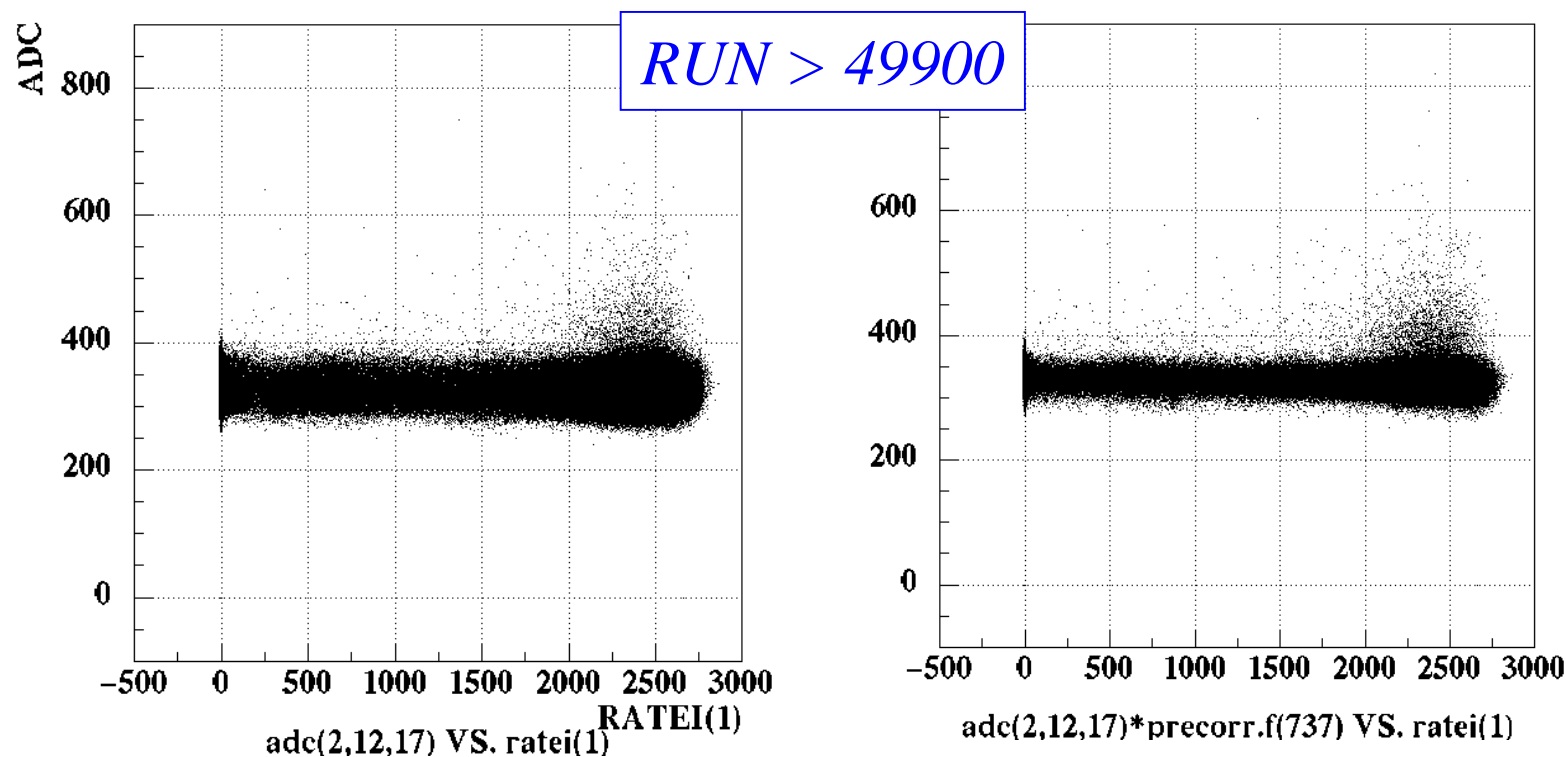
ADC(2,12,17)
VS RUN

Peak [ADC Count]



Events after Run-by-run correction

ADC profile before / after run-by-run gain correction

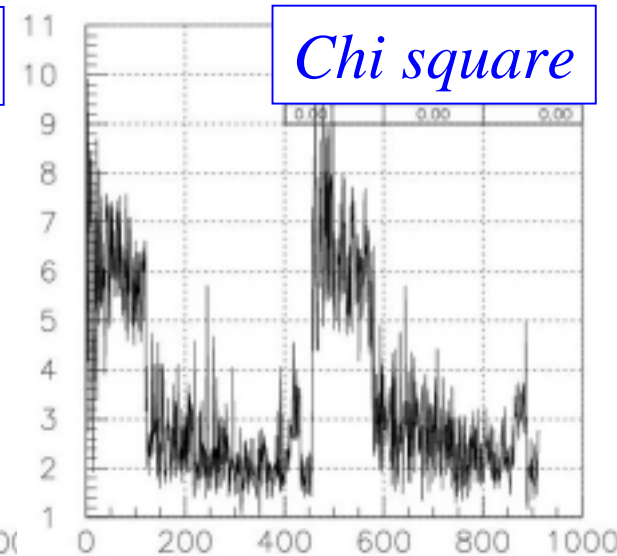
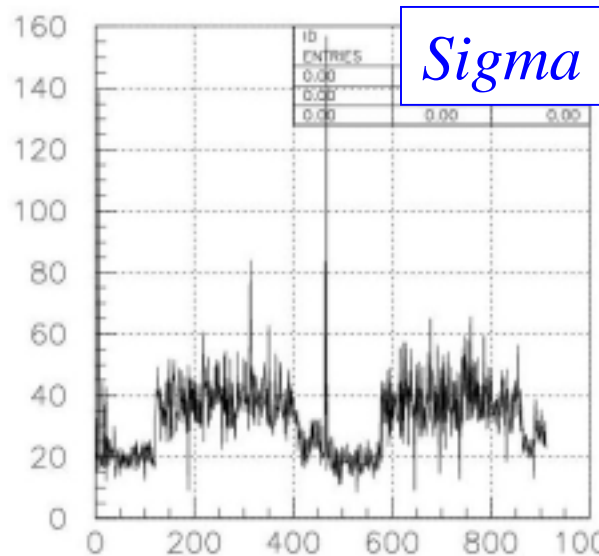
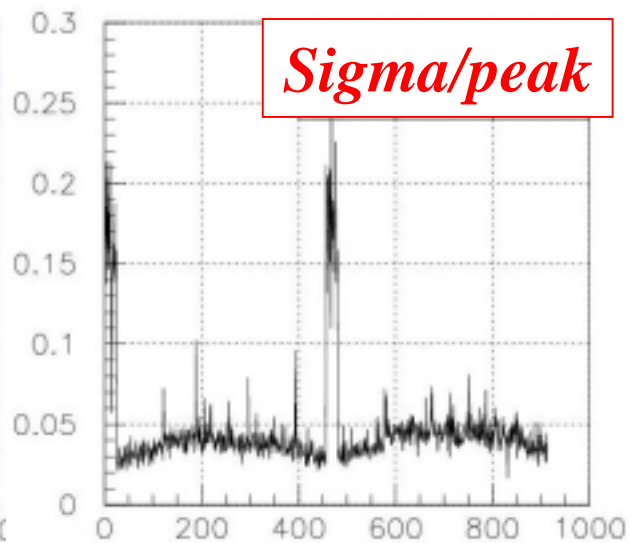
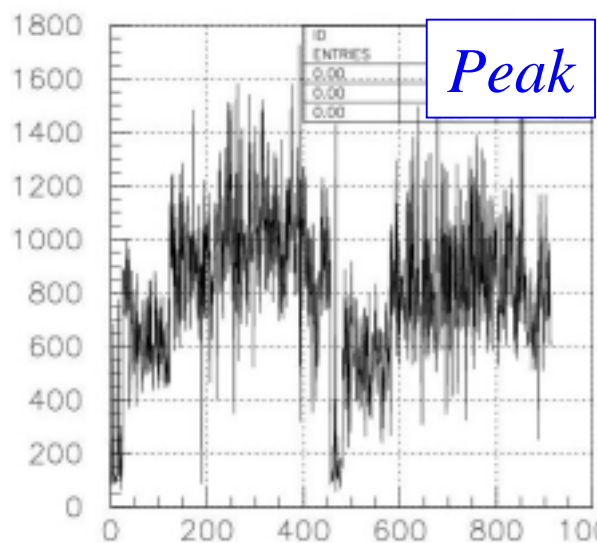


Raw ADC(2,12,17)
vs RateI(1)

Run-by-run gain corrected
ADC(2,12,17) vs RateI(3)

Estimation by pre-calibration

Because we select the rate-TIS-effect independent events (called ‘sweet part’), this can be a good *goal* of rate-TIS-effect correction.



Run>49900

X-axis is the index of RS PMT.

Pre-calibration

summary

- (1) Run-by-run gain tracking resolution is $< 0.4\%$ only with sweet part.
- (2) Run-by-run gain variation is revealed using the 'sweet part' of the RSMON events
- (3) These data are stored as a table of correction factor in database
- (4) About 50 % gain shift is monitored by RSMON after run 49900.

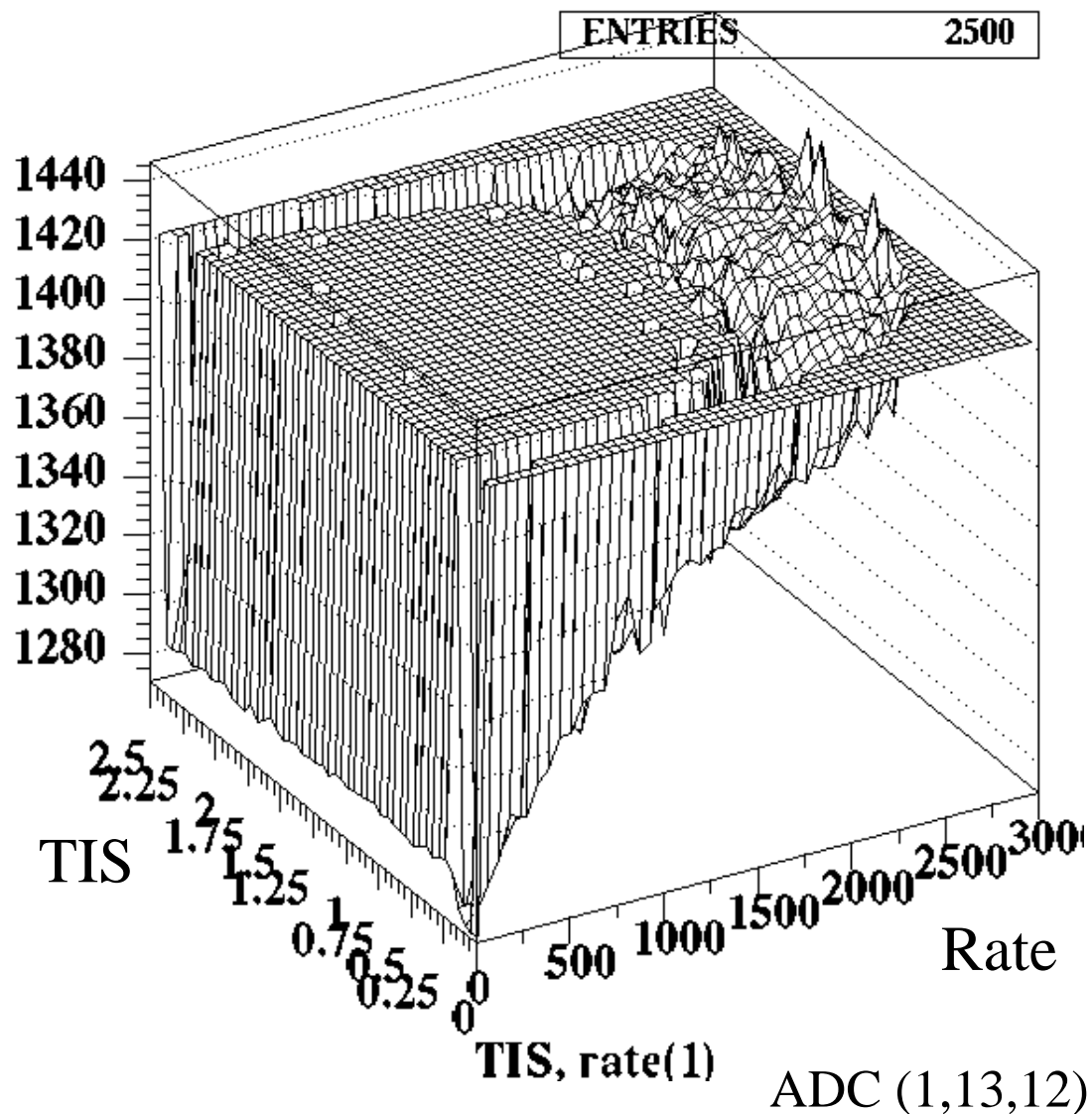
Correction for Rate effect

Matrix-Method

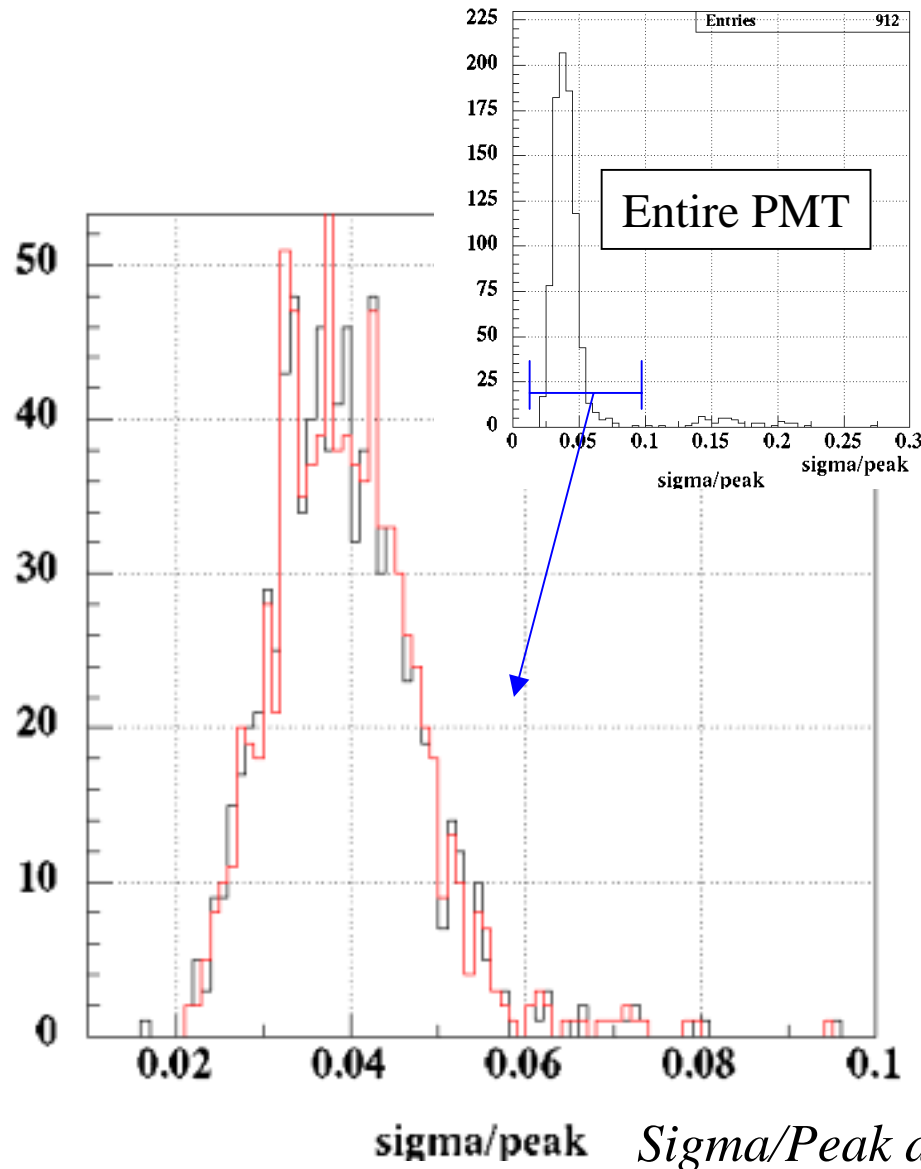
Rate-TIS Profiling
(RUN > 49900)

Rate : I-hung rate monitor
100ms time const.

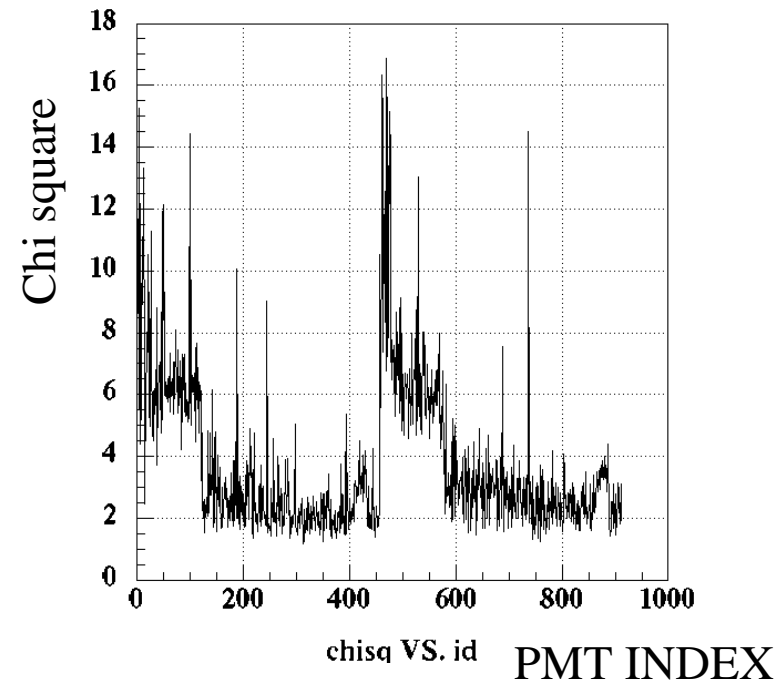
Based on profile matrix,
Calculate gain shift from
usual gain. And use it as
correction factor.



Self Correction Results/Quality

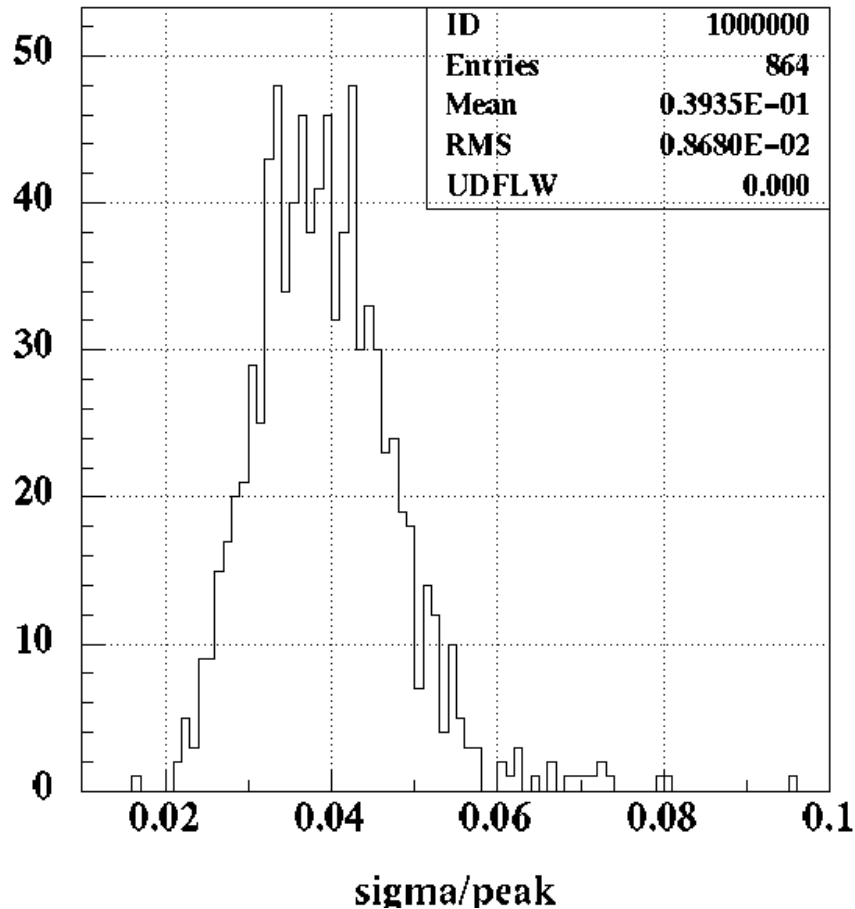


Matrix Method can get the same performance which is estimated at pre-calibration.

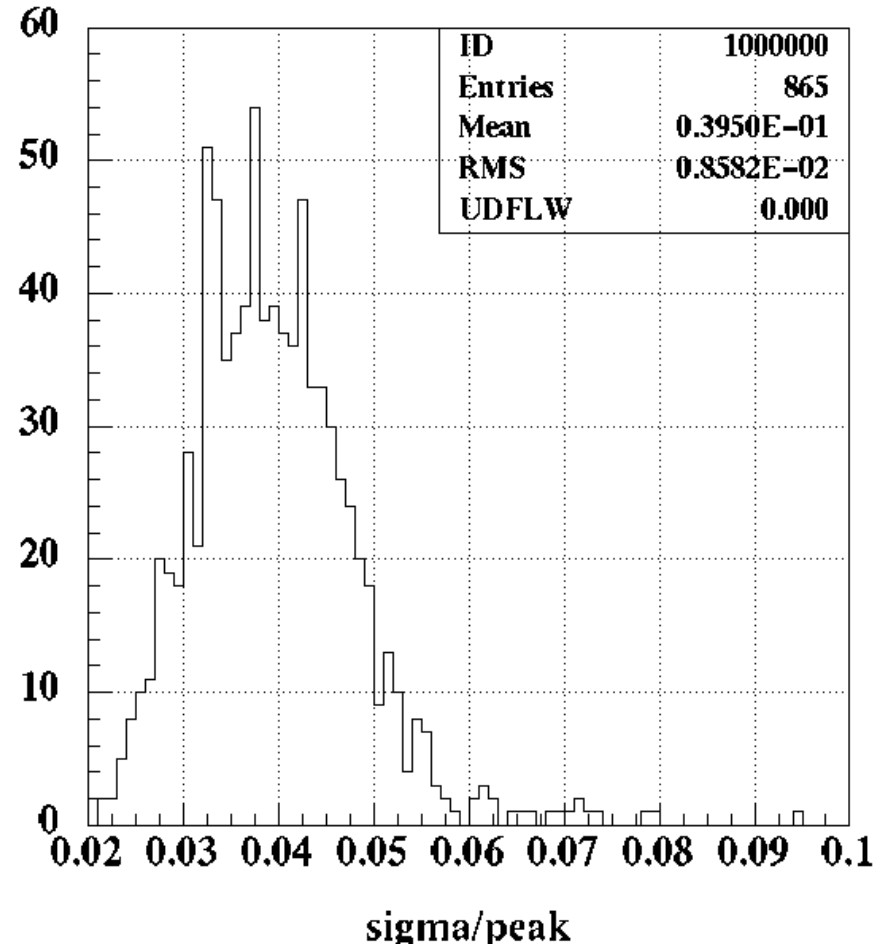


Self Correction Results/Quality

Appendix *Enlargement : $\sigma/\text{peak} < 0.1$ region*



pre-calibration



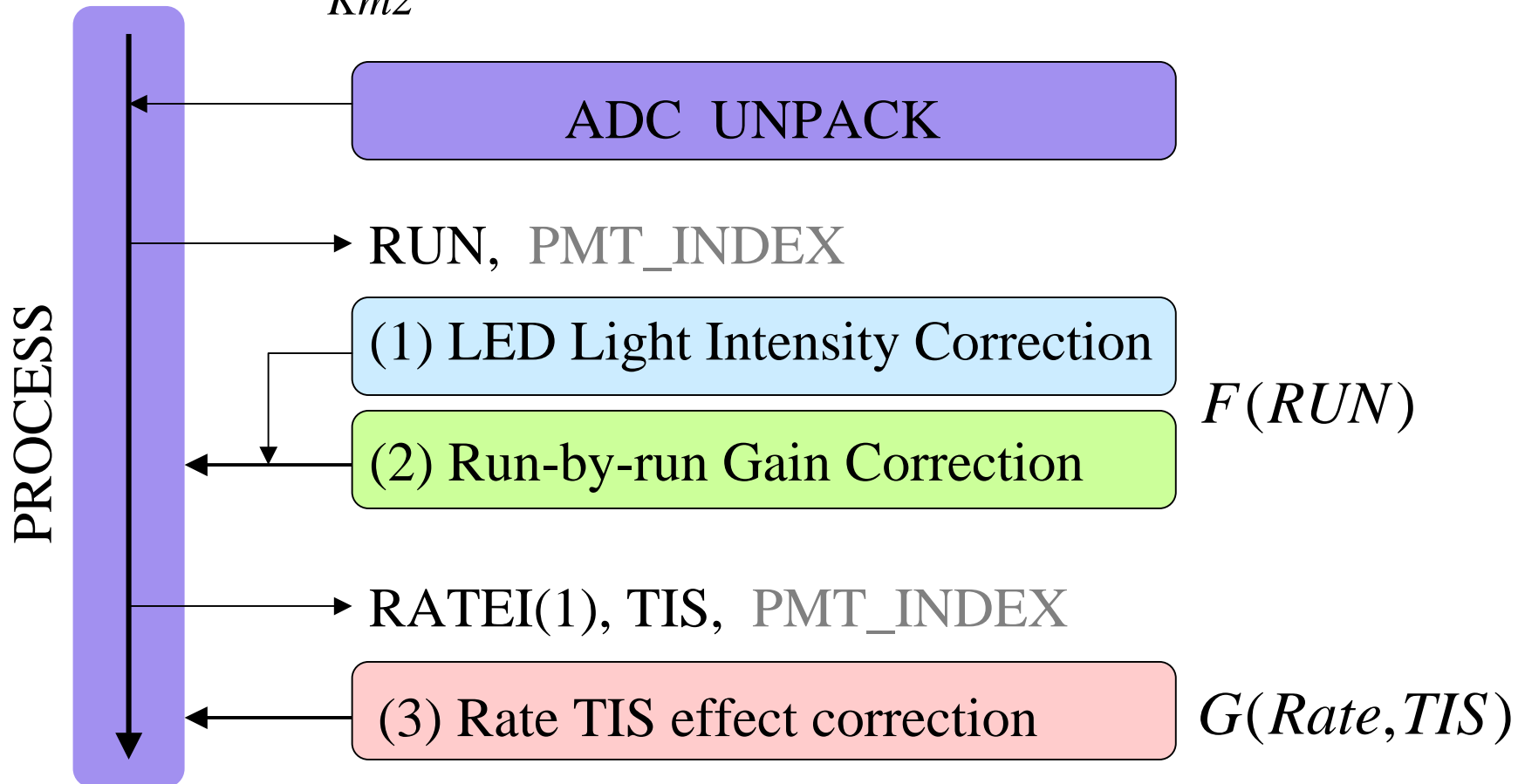
Matrix Method

*Energy Correction
based on RSMON*

Step by Step in RSMON Correction

Actually, what is done in RSMON source code ?

$$RDCAL(i, j, k) = \underset{Km2}{GAIN_{ijk}} \times F_{ijk}(RUN) \times G_{ijk}(Rate, TIS) \times RDPED(i, j, k)$$



Database

How many and What kind of Database is required for RSMON ?

LED Intensity
Database.

Chunk
(~20 run)

[Unit]

Run-by-run
gain correction
Database.

Run

Rate-TIS-effect
Function Form

(Small number
of CFM files.)

Other calibration data set

Ex. pedestal correlation curves which is used at
pedestal estimation in REREF event analysis.

Demonstration

*What kind of demonstration is required to confirm
RSMON based correction is*

(A) ready

(B) effective ?

Self correction

(A-1) RDCAL vs RUN

(A-2) RDCAL vs TIS

(A-3) RDCAL vs Ck rate

(A-?) RDCAL vs Sector ?

(B-1) Kp2 Energy
peak width

(B-2) Kmu2 ?

Any other good test ? Suggestions are welcome.

Summary

LED Intensity stability is checked and its fluctuation is less than 3 %

Pre-calibration is done and run-by-run gain fluctuation table is gotten. Gain fluctuation width is 50% after run 49900

About Rate-TIS-effect, It is confirmed that matrix method has enough correction power.

Preparation for installation of RSMON based correction into PASS2 starts.